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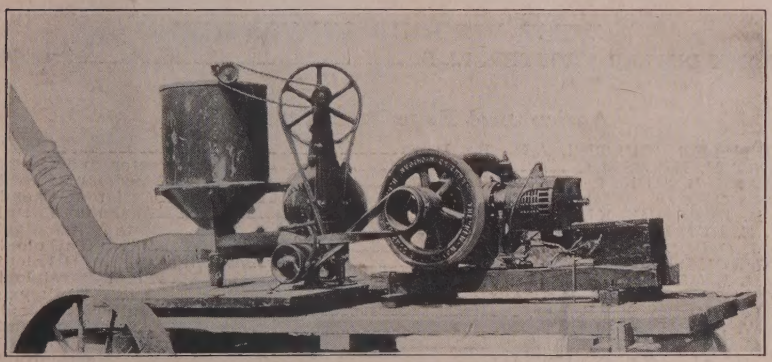
DEPARTMENT OF PLANT PATHOLOGY

Orchard Spraying Versus Dusting



Close View of One Type of Dusting Outfit.

BY
N. J. GIDDINGS

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CONCLUSIONS AND RECOMMENDATIONS.

The dust treatments have been found very effective for the control of biting or chewing insects.

Apple orchard diseases occurring in West Virginia have not been satisfactorily controlled in any of the experimental work with dust mixtures.

The dust materials have given just as good results as standard spray materials in the control of peach diseases.

After four years of experimental work it is not felt that the dusting method is to be recommended in West Virginia apple orchards where scab or sooty blotch is severe, or for the treatment of bitter rot, black rot, or blotch, unless it is desired primarily for the control of insects such as codling moth, curculio, canker worm or caterpillar.

An apple orchard in which it is absolutely impracticable to use a spray machine would doubtless derive considerable benefit from the use of dust for insect control; and in a very well-kept orchard, which is practically free from leaf spot, sooty blotch, and scab it might be advantageous to use a dust outfit for treatment against codling moth.

Since the sulphur dust was found quite effective against peach scab and brown rot it is believed that the method may be found of much practical value in the peach orchard.

Small Power Duster at Work in Peach Orchard.

Orchard Spraying Versus Dusting

By N. J. GIDDINGS *

By this time probably every person who owns a commercial orchard has heard or read more or less about the use of dust materials as a substitute for spray in the control of insects and diseases. It is generally conceded that there are many advantages in the dust method of applying insecticides and fungicides, provided the cost of materials is not too great and the insects and diseases are effectively controlled. Some of the advantages in the use of dust are:

(1) One man and a driver can in the same time thoroughly cover several times as many trees as two men and a driver with an ordinary spray outfit.

(2) It is not necessary to have a large water supply available.

(3) The haulage problem is greatly simplified since the entire dusting outfit is compact and light, and it is not necessary to carry a great weight of water as when using liquid sprays.

The features mentioned are such that they are certain to attract attention in any section of the country and they are especially important in West Virginia where many orchards are situated on rather steep slopes which render the use of a spray outfit difficult. In most commercial orchards it is also an item of considerable expense to secure an adequate and convenient water supply.

While the dusting method has these attractive features, the questions of more vital interest and importance are: First, Is the cost of this method actually less than that of spraying, and second, Are the dust materials effective in controlling orchard diseases and insects?

The Departments of Entomology and Plant Pathology of the West Virginia Agricultural Experiment Station have been conducting a series of experiments to determine the facts in regard to dusting as related to West Virginia orchard conditions. The investigations were conducted in both apple orchards and peach orchards, but the work with peaches has been carried out more extensively and with far more satisfactory results. This bulletin takes up the peach dusting experiments in some detail and gives a brief general statement of the work with apples. It is planned to continue the apple dusting experiments and to publish the detailed results of this work at a later date.

* The author desires to acknowledge co-operation and valuable assistance in connection with this work from Prof. L. M. Peairs, Prof. W. E. Rumsey, and Mr. Anthony Berg.

The project was started in 1913 by the Departments of Entomology and Plant Pathology, with Prof. Peairs in charge, and his conclusions regarding insect control are included in this publication.

MATERIALS AND EQUIPMENT

Various insecticides have commonly been used in dust form and have generally been quite satisfactory. The use of sulphur for controlling certain plant mildews was recommended as early as 1821. Sulphur dust is, and for many years has been, the standard remedy for powdery mildew on the grape, rose, and some other plants, but these particular diseases are not usually important in West Virginia. The development of improved machinery for distributing dust materials finally raised the question as to the advisability or practicability of using this method with other crops and for other troubles, as a substitute for spraying.

During the period from 1900 to 1910 several experiment stations tested the value of dust mixtures containing lime, dry Bordeaux, and Paris Green, sometimes with the addition of sulphur. Practically all of these earlier trials indicated that the dust materials used were not very effective in the control of orchard diseases.

In 1913 the Union Sulphur Company, in co-operation with the Corona Chemical Company and the Kansas City Dust Sprayer Manufacturing Company, kindly offered to furnish the materials and equipment for an extensive series of experiments in different sections of the country. They agreed to supply a very finely ground sulphur dust, on the theory that the materials previously used might have been too coarse to give the best results. It is readily understood that the finer such a material is ground, the more perfect will be its distribution and it is also well known that the chemical activity of such a material is greatly increased by having it in very small particles so that more surface is exposed.

The West Virginia Experiment Station joined the investigation because it had to do with problems the solution of which might mean much to the fruit growers of West Virginia.

The dust mixture used in most of the station's experimental work consisted of 90 percent superfine sulphur and 10 percent dry arsenate of lead, but for the application late in the season the arsenate of lead was omitted and a mixture composed of 80 percent sulphur and 20 percent lime was used. The finely ground sulphur, when used alone, has a tendency to form small lumps. Either the dry arsenate of lead or the air slaked lime serves to prevent this lumping and aids materially in securing a uniform distribution of the material. It is possible that the sulphur might be considerably diluted with lime and still give satisfactory results, but this point has not been well worked out as yet.

The equipment used during the seasons of 1913, 1914, and 1915 consisted of a Kansas City "Ideal" power dusting outfit mounted on a low wheeled farm truck. In 1916 a Niagara power dusting outfit was secured, and both types were used during the sea-

sons of 1916 and 1917. Both of these machines were found to be quite effective and satisfactory for distributing the dust materials. There are certain advantages and certain disadvantages in each of the machines but the principles of dust distribution are the same in both. The essential parts are a hopper to hold a supply of the material, an outlet and feed control arrangement in the bottom of the hopper, a high-speed blower which forces a strong current of air through a pipe underneath the hopper so as to carry away the dust as it is fed through, and a delivery tube with a flexible joint so that the outcoming stream of air and dust may be properly directed.

METHODS

The manipulation of a dust machine is very simple, but a little practice is necessary before one can regulate the feed and direct the delivery tube so as to do thorough work with a minimum amount of material. The air-borne dust moves rather slowly as compared with a spray mist forced out under high pressure and consequently is more easily affected by breezes or air currents in the orchard.

The material is easiest applied when the air is quiet or when there is only a very light breeze. If there is too much breeze the dust does not have sufficient opportunity to settle upon the trees, while the absence of air movement is most favorable for effective work. A variable or gusty wind is particularly undesirable and if it seems necessary to use the duster at such a time it is often best to stop the machine for a moment until the wind resumes its previous direction or velocity. The morning hours seem best suited for dusting although it is preferable to wait until the dew has dried from the leaves.

It has often been suggested that dust applications be made at a time when the plants are wet with rain or dew, but a more perfect distribution can be secured by applying it when the trees are dry. The dust applied to leaves or fruits when they are dry will settle very uniformly over the entire surface and will find its way among the tiny hairs to better advantage than the usual spray applications, but if the dust comes in contact with drops of water it will tend to collect in small masses at the edges or centers of the drops. The fine dust is very well retained by the hairy and waxy surfaces of fruits or leaves.

It is sometimes assumed that a tree should be heavily dusted so that the material will show from a distance as in the case of a spray but there is danger of serious burning if too heavy a coating of dust is given. With the larger power outfits it is seldom, if ever, necessary to stop the team in order to throw a sufficient amount of dust upon the tree. The machine should generally be kept moving through the orchard while dust is being discharged, and it is usually necessary to close down the feed somewhat, especially when dusting small trees.

In the case of peach trees or small apple trees closely planted, it is often practicable to dust as many as three rows at once. As previously stated the application should be made when there is very little wind, and under such conditions the dust will settle very uniformly over all parts of the tree.

RELATIVE COST OF DUSTING

The experience of the writer has been that the cost of materials required for efficient dust applications is considerably greater than for sprays. One-fourth to one half pound of dust per tree was found to be sufficient for one application on peaches, but the size of the trees and the distance between them are two important factors which influence the amount needed.

An average of the records secured for the seasons of 1915, 1916, and 1917 shows that at least twice as much sulphur was required per tree for an application of dust as for an application of spray. Moreover the sulphur used for dusting is ground especially fine and costs 30 to 50 percent more per pound than that used to make the self-boiled lime and sulphur. The cost of materials for an application of dust is therefore about three times as much as the cost of materials for an application of spray on an equal number of similar peach trees.

As to the question of time, it was found that one man and a driver with a dusting outfit can dust between three and four times as many trees per hour as two men and a driver can spray with the ordinary power spray outfits. Time records from four different orchards give the average time for spraying as 24 seconds per tree or 100 trees in 40 minutes; while the average time for dusting was 7.2 seconds per tree or 100 trees in 12 minutes. With the spray outfit it was customary to handle two rows at a time, and short but frequent stops were necessary. It was generally practical to cover three rows at a time with the dusting machine, and the team was kept moving at a good walk.

INJURY FROM USE OF DUST

There is a possibility of injuring peach foliage and fruit under certain conditions, particularly if too much dust is applied. No appreciable injury to the fruit has been observed under West Virginia conditions, but some leaf burning has been noted in one orchard. The amount of such foliage injury was not sufficient to cause any appreciable defoliation, but did indicate that trouble of that kind might sometimes occur. Dusting experiments conducted by the Georgia State Board of Entomology * resulted in a large amount of fruit injury, but they reported that the dust machine was stopped beside each tree and that excessive amounts of material were applied.

* Chase, W. W.—Dusting and Spraying of Peaches, Georgia State Board of Entomology, Circular 21, (1917).

RESULTS SECURED IN VARIOUS ORCHARDS

The first peach dusting was done in 1914, when a short row of nine-year-old peach trees was treated in Dr. A. P. Thompson's orchard at Summit Point, West Virginia. A series of apple dusting and spraying experiments was being carried on in an adjoining apple orchard of Dr. Thompson's and these few peach trees were dusted with the thought that it might be well to try the effect of sulphur dust on a peach orchard where there was serious injury from scab and brown rot. It happened that the few trees dusted included all there were of that particular variety and it would have been improper to compare these with untreated trees of another variety. Specific data were not secured from these trees, but there was no evidence of injury. Dr. Thompson reported that this was the first season that they had matured any fruit. Since the control of brown rot and scab seemed fairly effective in this case, a more extensive trial was planned for 1915.

Experiments Conducted in 1915

Experiments were conducted in 1915 at Summit Point, West Virginia, in Dr. A. P. Thompson's old peach orchard. The orchard was 16 years old and situated on practically level ground with a slight rise near one end. A large block of Late Crawford and an adjoining block of Mountain Rose were selected for the principal experiments because of the fact that Dr. Thompson said these varieties suffered much from rot and curculio. The trees were divided into six plots, each plot including trees of both varieties. Plot 1 was to receive the self boiled lime-sulphur mixture. Plot 2 was to receive sulphur dust. Plot 3 was to receive sulphur dust diluted with gypsum. Plot 4 was to receive the material known as B. T. S. (barium thiosulphate) put out by the Thomsen Chemical Company. Plot 5 was to receive paste sulphur. Plot 6 was left untreated for a check. The trees in all plots contained a considerable number of brown rot mummies and there were large numbers of them upon the ground throughout the orchard.

Each plot contained about one hundred and fifty trees and they had a considerable amount of bloom but fruit did not set well. As a result of the very light set, when it came time to make the application it was thought best to include also a test upon some Elberta. The dust was therefore applied upon one plot of Elberta including about three hundred trees.

Some dusting and spraying experiments were being conducted upon apple trees at Millville and the dusting machine was there early in the season so that an early application for curculio on peaches was omitted.

The first dusting was given on May 28 and the second July 3. The sulphur dust was applied at the rate of about seventy-five pounds

per application on the Late Crawford and Mountain Rose while the sulphur and gypsum mixture (50 percent sulphur, 40 percent gypsum and 10 percent arsenate of lead) was applied at the rate of about forty pounds per application on the Late Crawford and Mountain Rose. The material was quite difficult to handle in the dusting machine as it showed a strong tendency to cake. The spray materials used were made up according to the standard directions and were thoroughly applied.

On the Elberta the materials were used at about the same rate and the first application, that on May 28, was made with the sulphur-gypsum mixture, while the second application, on July 3, was made with the sulphur dust.

There were no unsprayed checks among the Elberta. The trees which we used as checks in connection with this variety were some which Dr. Thompson sprayed once with self-boiled lime-sulphur about the first of June.

No data were taken from the fruit which dropped during the season previous to picking time. Six dusted trees and seven check trees were selected for data on the Elberta, while the fruit from seven to ten trees was collected in each of the blocks of Late Crawford.

The peaches were picked from August 22 to 24. At that time all peaches which were on the ground were included in the data. The peaches from each tree were carefully picked and sorted as to curculio, rot, scab, and sound. Unfortunately the Mountain Rose peaches were picked without the writer's being notified, otherwise more reliable data would undoubtedly have been secured from them than from the Late Crawford because there were a considerably larger number on the trees.

The detailed results are given in the following table:

TABLE I.—PEACHES AT THOMPSON ORCHARD (1915)

TREATMENT	Total	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Check sprayed once....	6056	288	4.8	5768	95.2	1288	21.3	677	11.2	Elberta
Sulphur dust.....	4289	2017	47.0	2272	53.0	564	13.2	598	14.0	Elberta
Self-boiled lime-sulphur	376	18	4.8	229	60.9	97	25.8	338	90.0	Late Crawford
Sulphur dust.....	240	33	13.7	8	3.3	74	30.8	207	86.2	Late Crawford
Sulphur gypsum dust...	229	53	23.2	6	2.6	54	23.6	176	76.8	Late Crawford
Barium thiosulphate spray.....	91	0	0.0	67	73.6	81	89.0	60	66.0	Late Crawford
Paste sulphur spray....	311	51	16.4	208	66.9	115	37.0	238	76.5	Late Crawford
Check, untreated.....	190	2	1.1	160	84.2	90	47.3	129	62.9	Late Crawford

It will be noted that the dust was very effective in controlling scab, fair in its control of rot, and that there was practically no control of curculio. This result was what might have been expected and it

is quite likely that the control of rot would be much better if the curculio were also controlled. There was a very high percentage of curculio injury on the Late Crawford doubtless due in part to the fact that there were comparatively few fruits for them to work on.

Experiments Conducted in 1916

Experiments in the Arnold Orchard. This orchard is situated about five miles from Keyser, W. Va., at the home of J. Sloane Arnold. It is surrounded on three sides by woodland and is on rather low ground. Mr. Arnold stated that in 1915 his crop was almost an entire loss as the result of injury due principally to scab. The orchard contained apple trees interset with peaches, there being three peach trees to each apple tree. There were 40 rows and 43 trees per row. There were five varieties of peaches and the experimental blocks were arranged crosswise of the variety rows, so that results might be secured from the different kinds of peaches. Four rows on one side were selected as a check plot, ten rows were selected for the dusting experiments, the next fourteen rows were dusted by Mr. Arnold, the next eight rows formed a spray block, and the next four rows were another check.

The first application was made in this orchard on May 19, which was a little too late for effective curculio control. One hundred and thirty pounds of the 90 percent sulphur 10 percent arsenate were applied to the 430 trees, comprising 323 peach trees and 107 apple trees. Considerable trouble was experienced with the dusting machine when this application was made and it was not entirely satisfactory. One hundred gallons of atomic sulphur containing five pounds of arsenate of lead paste and five pounds of lime were applied on 344 trees, comprising 258 peach trees and 86 apple trees. The atomic sulphur was used at the rate of seven or eight pounds to fifty gallons of water.

The second application was made June 3, at which time one hundred and twelve pounds of sulphur-arsenate mixture were applied to the same block as before. One hundred gallons of atomic sulphur plus arsenate of lead were applied to the spray block.

The third application was given July 6, at which time one hundred and thirty pounds of 80 percent sulphur 20 percent lime were applied to the dust block. One hundred gallons of atomic sulphur without arsenate were applied to the spray block.

The first variety to ripen was the Greensboro and this was picked July 18. The second variety to ripen was Carmen, which was picked July 26 and 27. The third variety to ripen was Rav, which was picked August 18. The fourth variety to ripen was Elberta which was picked August 26. Data were taken on the fruit from five trees in each plot unless otherwise stated. The results secured from this orchard are given in Table II.

TABLE II.—PEACHES AT ARNOLD ORCHARD (1916)

TREATMENT	Total Number Peaches	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Atomic sulphur	1275	1038	81.4	143	11.2	1	0.1	97	7.7	Greensboro
Sulphur dust	1292	973	75.3	153	11.7	19	1.4	130	9.9	Greensboro
Check, untreated (7 trees)	1781	372	20.9	1217	63.2	64	3.6	259	14.6	Greensboro
Atomic sulphur	439	146	33.2	276	62.8	1	.2	42	9.5	Carmen
Sulphur dust	338	137	40.5	163	48.1	0	.0	57	16.7	Carmen
Check, untreated	497	3	0.6	453	91.1	12	2.4	129	25.9	Carmen
Atomic sulphur	1266	674	53.2	498	39.3	0	.0	115	9.1	Ray
Sulphur dust	645	470	72.8	72	11.1	0	.0	108	16.7	Ray
Check, untreated	1128	12	1.0	1110	98.4	0	.0	118	10.3	Ray
Atomic sulphur (2 trees)	342	7	2.5	335	98.0	0	.0	18	5.3	Elberta
Sulphur dust (2 trees)	387	52	13.4	331	85.4	1	0.3	19	4.9	Elberta
Check, untreated (2 trees)	442	0	0.0	439	99.2	0	0.0	27	6.1	Elberta

The curculio control was as good as could have been expected, and there was not enough brown rot to warrant any conclusion. Scab was very well controlled and both spray and dust were far more effective than would be indicated by the figures. In other words, there were many sprayed or dusted fruits which had only one or two small scab spots, and practically uninjured for market value, but classed in the table as fruit with scab on it. Some commercial data were secured in this connection and reference to Table VII will bring out some facts in regard to this.

Experiments in the Thompson Orchard.—The peach trees in Dr. A. P. Thompson's orchard at Summit Point, West Virginia, were in what is known as the old peach orchard and were about seventeen years old. The trees were very good size and had a fair amount of bloom. The varieties included in the experimental plots were Oldmixon and Stump.

The first treatment was given May 16. It was intended to make this application sufficiently early for curculio control, but the season advanced with unusual rapidity and a considerable amount of curculio injury was already apparent. One hundred pounds of 10 percent arsenate 90 percent sulphur dust mixture were applied to 446 trees, and 130 gallons of the self boiled lime-sulphur, 8-8-50, were applied to the block of 211 trees. Four pounds of dry arsenate of lead were used with the spray material.

The second treatment was given June 1. At this time 144 pounds of the 10 percent arsenate 90 percent sulphur dust mixture were used on the dust plot and 150 gallons of self-boiled lime-sulphur were used on the spray plot.

The third treatment was given July 7, at which time 80 pounds of the 80 percent sulphur 20 percent lime dust mixture were used

on the dust plot and 125 gallons of self-boiled lime-sulphur were used on the sprayed plot.

The Stump peaches were picked August 21, and the Oldmixon, August 28. The results are shown in the following table:

TABLE III.—PEACHES AT THOMPSON ORCHARD (1916)

TREATMENT	Total Number Peaches	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Self-boiled lime-sulphur (6 trees)	1586	372	23.5	528	33.4	325	20.5	752	47.5	Oldmixon
Sulphur dust (6 trees)	1034	167	16.2	296	28.7	191	18.5	637	61.8	Oldmixon
Check, untreated (6 trees)	412	8	1.9	185	45.0	153	37.1	253	61.5	Oldmixon
Self-boiled lime-sulphur (7 trees)	1754	400	23.0	629	36.0	441	25.2	712	40.7	Stump
Sulphur dust (7 trees)	1263	125	9.9	690	54.7	310	24.5	693	54.8	Stump
Check, untreated (7 trees)	682	4	0.6	323	47.3	305	44.8	545	80.0	Stump

Scab control was very good, although the figures in the above table might not so indicate. Here, as in the Arnold orchard, the fruits from sprayed or dusted trees showed only occasionally scab spots, while those from check trees were often badly deformed by it. This fact is well brought out by Table VII. The remarkable difference in number of peaches per tree for these plots was probably a result of winter injury, as the sprayed plot was on the highest ground and the check plot was on the lowest ground. Careful notes were not taken as to the amount of bloom, but records were kept of all dropped fruit.

Experiments in the Alkire Orchard.—The Alkire orchard is situated about one mile out from Keyser on a steep side hill. The variety selected was Connett, the trees were medium size and had a fair amount of bloom. The dust machine used was the Niagara small power outfit, mounted on a sled.

The first application was made May 18. At that time 60 pounds of the 10 percent arsenate 90 percent sulphur dust were used on 198 trees. The spray block was not treated until May 20, at which time 100 gallons of self-boiled lime-sulphur were applied to 143 trees. One and one-half pounds of dry arsenate of lead were used in 100 gallons of spray material. It was found here again that the curculio had already accomplished some injury to the peaches, although not as much as was apparent in Jefferson County.

The second application was made June 3, when 70 pounds of 10 percent arsenate 90 percent sulphur dust were applied to the dust plot and 100 gallons of self-boiled lime-sulphur were applied to the spray plot.

The third application was made July 5, when 45 pounds of the 80 percent sulphur 20 percent lime dust were applied to the dust plot

and 100 gallons of the self-boiled lime-sulphur were used on the spray plot. The 100 gallons of spray material were not quite sufficient to cover the entire plot.

It should be noted that the side hill was so steep that the sled could hardly be kept straight any of the time. It slid down the hill sidewise and was very difficult to manage. Care was taken to select the spray block where there was a road so that the trees could be reached. There was a great deal of trouble from the wind in this orchard, situated as it was on the side of a hill and facing another hill. The land formed a ravine which opened out to a wide expanse of comparatively level ground at either end. The air currents appeared to come first from one direction and then from the other, with extreme variation. This difficulty was encountered to a greater or less degree each time the dust was applied to the trees. The peaches were picked July 31. There was comparatively little of either scab or brown rot, but both spray and dust gave good control. The peaches were also quite free from insect injury. The results are given in the following table:

TABLE IV.—PEACHES AT ALKIRE ORCHARD (1916)

TREATMENT	Total Number Peaches	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Self-boiled lime-sulphur	422	369	87.4	2	0.4	4	0.9	48	11.3	Connett
Sulphur dust.....	541	492	90.9	4	0.7	2	0.3	43	7.9	Connett
Check, untreated.....	495	399	80.6	39	7.8	15	3.0	48	9.6	Connett

EXPERIMENTS CONDUCTED IN 1917

Experiments in the Arnold Orchard.—This is the same orchard used in the work in 1916 with Mr. Arnold, and Greensboro, Carmen, Ray, Elberta, and Salway varieties were experimented upon.

The first application was made May 14. At that time the husks were just broken loose from the base of the young fruits on the later varieties, while on the earlier varieties the husks were starting to shed. There was no sign of curculio work. The weather was clear but with a cold wind.

The sulphur dust containing 10 percent arsenate of lead was applied to 172 trees. The atomic sulphur, 6 pounds to 50 gallons of water and 1-½ pounds of dry lead arsenate to 50 gallons were used and 80 gallons were required for 172 trees.

The second application was made May 31 at which time 75 pounds of the sulphur arsenate dust were used and 50 gallons of atomic sulphur.

The third application was made July 17 and the amount of material used was about 55 pounds of dust and 50 gallons of spray.

The peaches were picked as follows:

Greensboro on July 24; Carman on August 7; Ray on August 27; Elberta on August 28; Salway on September 29.

The results are given in the following table:

TABLE V.—PEACHES IN THE ARNOLD ORCHARD (1917)

TREATMENT	Total Number Peaches	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Atomic sulphur	1481	1375	92.9	92	6.2	0	.0	14	0.9	Greensboro
Sulphur dust	1955	1813	92.8	130	6.7	1	0.1	11	0.6	Greensboro
Check, untreated	802	474	59.1	321	40.0	3	0.4	8	1.0	Greensboro
Atomic sulphur	1399	1125	80.5	251	17.9	0	.0	27	1.9	Carmen
Sulphur dust	1270	1064	84.0	183	14.4	0	.0	23	1.8	Carmen
Check, untreated	953	247	25.9	690	72.5	0	.0	26	2.7	Carmen
Atomic sulphur	791	670	84.7	88	11.1	0	.0	38	4.8	Ray
Sulphur dust	646	602	93.2	20	3.1	0	.0	26	4.0	Ray
Check, untreated	648	228	35.2	416	64.2	0	.0	12	1.8	Ray
Atomic sulphur	102	31	30.4	69	67.6	0	.0	7	6.9	Elberta
Sulphur dust	97	82	84.5	10	10.3	0	.0	6	6.2	Elberta
Check, untreated	107	0	0.0	106	99.1	0	.0	14	13.1	Elberta
Atomic sulphur	385	320	83.1	52	13.5	0	.0	13	3.4	Salway
Sulphur dust	318	297	93.4	12	3.8	0	.0	9	2.8	Salway
Check, untreated	670	12	2.1	536	94.0	0	.0	22	3.9	Salway

The scab control was excellent by both dust and spray. It may be noted that the treatments seemed least effective on Carmen and Elberta during the seasons of both 1916 and 1917, but this may be of no particular significance.

Experiments in the Thompson Orchard.—The dusting and spraying experiments in the Thompson orchard were made upon the Elberta variety in what is known as the old orchard. The first treatment was given May 12. At that time 75 pounds of sulphur dust containing 10 percent dry lead arsenate were used on 95 trees, and 40 gallons of the self-boiled lime-sulphur containing 1-½ pounds dry lead arsenate were used on 64 trees.

The second application was made May 31. At that time 30 pounds of sulphur containing 20 percent lime were applied to the dust plot. Eighty gallons of the self-boiled lime-sulphur were applied to the spray plot. No arsenate was used in the self-boiled lime-sulphur. There was a rather strong wind from the West when this application was made.

The third application was made July 12 and about 40 pounds of the 80 percent sulphur 20 percent lime were used on the dust plot. There was very little wind and the dust settled well on the trees. It should be noted that part of the sulphur used at this time was applied in the young orchard on a few trees of a late variety so that the total amount of sulphur used on the plot in the old orchard was less than 40

pounds. Fifty gallons of the self-boiled lime-sulphur were used on the spray plot.

There was a heavy thunder shower within a few minutes after making this spray application, but neither the spray nor the dust was put on again, as the orchard soil was very soft.

The peaches in the orchard were picked August 23 and the results are shown in Table VI.

Experiments in the Fulton Orchard.—The variety used in the S. H. Fulton orchard at Sleepy Creek, West Virginia, was Elberta and the trees were located on high, well drained, rolling land. The first treatment was given May 15 and at that time most of the husks had just broken loose at the base of the young fruit. There was no sign of curculio. The weather was clear with a cool northwest wind. Sulphur dust containing 10 percent lead arsenate was applied to 117 trees, using 35 pounds of dust. Atomic sulphur spray, 5 pounds to 50 gallons, and containing 1-½ pounds lead arsenate was applied to 60 trees, using 50 gallons of the material.

The second application was made on June 2, at which time sulphur containing 20 percent lime was applied, using 35 pounds of dust, and the atomic sulphur without lead arsenate was applied, using 50 gallons.

The third application was made July 10, at which time 30 pounds of the dust were used. The wind was quite variable and necessitated going over some of the same ground twice. The trees in the spray block received 40 gallons, but some of the trees had already been sprayed the previous week. These peaches were picked on September 2, with results as shown in the following table:

TABLE VI.—PEACHES IN THE THOMPSON ORCHARD (1917)

TREATMENT	Total Number Peaches	SOUND		SCAB		ROT		CURCULIO		VARIETY
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Self-boiled lime and sulphur	533	158	29.6	316	59.4	78	14.6	78	14.6	Elberta
Sulphur dust	578	211	36.5	334	57.8	104	18.	54	9.3	Elberta
Check, untreated	541	5	0.9	531	98.2	248	45.9	65	12.0	Elberta

THE FULTON ORCHARD (1917)

Atomic sulphur	486	451	92.8	13	2.7	5	1.0	17	3.5	Elberta
Sulphur dust	418	389	93.0	9	2.2	2	0.5	18	4.3	Elberta
Check, untreated	470	195	41.5	264	56.2	4	0.8	9	1.9	Elberta

The scab control in the Thompson orchard was very effective, in spite of the fact that many sprayed or dusted fruits showed occasionally a scab spot.

COMMERCIAL GRADING OF PEACHES FROM EXPERIMENTAL PLOTS

It was rather difficult to secure figures as to the commercial grades of fruit from the various plots, because it was not feasible to maintain some one at the orchard for the several day-periods required in commercially picking each variety, and it was difficult for the owners to keep track of the picking, handling, and grading so that the men would not mix peaches from the various plots.

The data given in Table VII under the Thompson orchard represent the same fruit from which the records in Table III were secured, while those given under the Arnold orchard show the amount of fruit from the entire experimental plots. In the Thompson orchard the fruit was sorted into two grades designated as "Good" and "Cull", and the fruit from the Arnold orchard was graded as "Fancy", "Choice", or "Cull". The culls from the latter orchard amounted to three and one-half bushels for the Ray and four bushels for the Carmen. The cull fruits from the different treatments here were not kept separate, but practically all of them were from the check plots for each variety.

TABLE VII.—COMMERCIAL GRADES OF FRUIT FROM EXPERIMENTAL PLOTS.

Thompson Orchard

TREATMENT	Total Fruit Bushels	GOOD FRUIT		CULL FRUIT		VARIETY
		Bushels	Percent	Bushels	Percent	
Spray	5¾	3¾	65.2	2	34.8	Oldmixon
Dust	3¾	2½	66.7	1¼	33.3	Oldmixon
Check	1¼	¼	20.0	1	80.0	Oldmixon
Spray	6¾	4½	66.7	2¼	33.3	Stump
Dust	4¼	3	70.6	1¼	29.4	Stump
Check	2¾	½	18.0	2¼	82.0	Stump

Arnold Orchard

TREATMENT	Total Fruit Bushels	FANCY FRUIT		CHOICE FRUIT		VARIETY
		Bushels	Percent	Bushels	Percent	
Spray	18¼	15	82.2	3¼	17.8	Ray
Dust	114	92	80.7	22	19.3	Ray
Check	20⅝	¾	3.0	20	97.0	Ray
Spray	8½	6	70.6	2½	29.4	Carmen
Dust	22½	20	88.8	2½	11.2	Carmen
Check	6¾	¾	11.1	6	88.9	Carmen

The foregoing results speak very favorably for the use of sulphur dust as a practical proposition in the peach orchard.

EXPERIMENTS WITH APPLES

Dusting and spraying experiments were conducted in commercial orchards during the seasons of 1914, 1915, and 1917. As previously stated, these have not been very satisfactory, and it is the plan to publish that part of the work separately, after further investigation. The insect control on fruits from dusted plots was excellent in 1914 and 1915, and there was so little insect injury in the orchard where the experiments of 1917 were conducted that the results were negligible.

Black rot, leaf spot, and common rust were the principal diseases in the apple orchards where experimental work was conducted the first two seasons, and there was no evidence that any of these diseases were appreciably controlled. The apple orchard used in 1917 did not receive any treatment previous to blossoming, so that the results are not considered very satisfactory. The later applications of spray were fairly effective in control of scab but not at all effective against sooty blotch; while the dusted plots showed practically no control of either of these diseases.